

NOTE

A New Maryland Record for *Cicindela splendida* Hentz (Coleoptera: Carabidae: Cicindelinae), with Notes on Taxonomic Status and Phylogenetic Relationships

Cicindela splendida Hentz has long been considered one of the rarest tiger beetles in the state of Maryland. In a review of the state's tiger beetle fauna, Glaser (1984) reported that he could only find two valid records of *C. splendida*. These records were based on collections from Calvert and Prince George's counties, of which the most recent was from 1948. With no recent records, Glaser (1984) concluded that *C. splendida* might actually be extirpated from Maryland.

Recent survey work by the author and colleagues at sites along the Patuxent River in Anne Arundel County, Maryland, has identified many previously unknown populations of tiger beetle species. Most recently, surveys by the author at the U.S. Fish and Wildlife Service's Patuxent Research Refuge identified a small population of *C. splendida* on Refuge property. On April 15, 2006, adults of this species were observed foraging and ovipositing in an area of bare, eroded red clay soil within an abandoned sand and gravel pit. The area where the beetles were observed was heavily eroded into a series of small (1–2 m deep) gullies. Other tiger beetle species present at this site on this date included *C. sexguttata* Fabricius and *C. tranquebarica tranquebarica* Herbst. Two voucher specimens of *C. splendida* were collected for deposition in the collection of the National Museum of Natural History, Smithsonian Institution (NMNH).

Cicindela splendida is closely associated with exposed, eroded red clay substrates throughout its range (Knisley and Schultz 1997, Pearson et al. 2006). Such

exposures are still common at this writing in central Maryland, in settings such as roadsides, railroad cuts, power line rights-of-way, drainage ditches, gullies, abandoned sand or gravel quarries, and abandoned clay pits. Comparison with the geological map of Maryland (Maryland Geological Survey 1968) indicates that the red clays in central Maryland, including those at Patuxent Research Refuge, are part of the Cretaceous Potomac Group. Specific formations within the Potomac Group which may include red clays are the Raritan and Patapsco Formations, as well as the Arundel Clay. These Potomac Group sediments underlie much of central Maryland, particularly in the corridor between Washington, D.C. and Baltimore. Given the abundance of suitable habitat, it is likely that additional populations of *C. splendida* exist in Maryland.

The apparent scarcity of *C. splendida* in Maryland is particularly surprising given the large number of specimens of this species collected during the first decades of the twentieth century at sites in the District of Columbia and northern Virginia, as demonstrated by the following records from NMNH. For completeness, I also include the few Maryland records from the NMNH collection.

District of Columbia: Rock Creek, 14.V.1899 (2 ♂, 1 ♀), 2.VI.1901 (1 ♂, 1 ♀), 14.IX.1902 (1 ♂).

Maryland: Prince George's County, Bladensburg, 21.IV.1920 (1 ♂); Fort Washington, on clay bank, steep ravine, 8.IV.1943 (1 ♂, 1 ♀), 6.IX.1943 (1 ♂, 1 ♀), 15.IX.1943 (1 ♀). Glaser (1984) also reports a collection from: Calvert County, Solomons, 20.IV.1948.

Virginia: Alexandria, 28.IV.1889 (1 ♀); 2.VI.1902 (1 ♀). Arlington County: Four Mile Run, 28.IX.1913 (1 ♂); Glencarlyn, 8.IV.1929 (1 ♂), 18.IV.1931 (1 ♂). Fairfax County: Barcroft, IX.1914 (1 ♂); Falls Church, 20.V.1917 (2 ♂), 5.V.1917 (1 ♂); Mount Vernon, 21.IX.1910 (1 ♀), 20.V.1917 (1 ♂), 21.IX.1919 (4 ♂, 5 ♀), 23.IX.1920 (2 ♀), 6.IV.1929 (5 ♂), 5.IV.1930 (1 ♂, 2 ♀), 24.IX.1930 (1 ♀), 30.IV.1931 (1 ♀), 15.IV.1933 (2 ♂), 11.IX.1936 (3 ♂, 2 ♀), 24.IX.1939 (1 ♂, 1 ♀); locality not specified, 21.IX.1919 (1 ♀), 19.IX.1920 (1 ♀).

Maryland, Virginia, and District of Columbia populations of *C. splendida* are readily separated from other sympatric tiger beetle species by the combination of 1) uniformly green or blue-green head and pronotum with 2) reddish or purplish elytra with green lateral margins and variable (but often highly reduced) white markings (Knisley and Schultz 1997). However, from a broader taxonomic perspective, the separation of *C. splendida* from a closely-related group of similar North American species has long been problematic. In the most comprehensive treatment to date, Schincariol and Freitag (1991) studied the adult morphology of taxa in their "*C. splendida* group" and concluded that three valid species were represented: *C. splendida*, *C. limbalis* Klug, and *C. denverensis* Casey. This conclusion has generated considerable discussion, because the three forms share similarities in coloration, are partially sympatric, and are known to mate with each other (Johnson 1979, Kippenhan 1994, Knisley and Schultz 1997, Pearson et al. 2006).

A recent molecular phylogenetic analysis of North American species of the genus *Cicindela* L. (Barraclough and Vogler 2002) provides an interesting resolution to these longstanding taxonomic questions. As expected, *C. splendida*, *C. limbalis*, and *C. denverensis* are

close relatives, part of a monophyletic group of similar species. However, these three species do not themselves form a monophyletic group. Rather, *C. limbalis* is the sister-species of *C. decemnotata* Say, while *C. splendida* is the sister-species of *C. purpurea* Olivier. These two lineages in turn form an unresolved trichotomy with *C. denverensis*. In the context of this analysis, Schincariol and Freitag's "*C. splendida* group" is clearly non-monophyletic.

More interestingly, this analysis suggests that *C. splendida*, *C. limbalis*, and *C. denverensis* have all existed as separate species for at least one million years. Barraclough and Vogler (2002) estimated divergence times for each lineage in their analysis, using nonparametric rate smoothing of branch lengths which had been estimated using maximum likelihood methods applied to DNA sequence data. The divergence of *C. denverensis* from the other two lineages is estimated to have occurred approximately 2 million years ago, the divergence of *C. limbalis* and *C. decemnotata* approximately 1.8 million years ago, and the divergence of *C. splendida* and *C. purpurea* approximately 1.0 million years ago. These estimates serve to bolster the conclusions of Schincariol and Freitag (1991) that *C. splendida*, *C. limbalis*, and *C. denverensis* are each separate and valid species.

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